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## ADDRESS TO:

Assistant Commissioner for Patents  
Box Patent Application  
Washington, D.C. 20231

Attorney Docket No. MBHB00-009  
First Named Inventor Mark O. Vogel  
Express Mail No. EL007258514US  
Total Pages (including transmittal)

## APPLICATION ELEMENTS

1. ☒ Transmittal Form with Fee
2. ☒ Specification (including claims and abstract) [Total Pages 26]
3. ☒ Drawings [Total Sheets 7]
4. ☐ Oath or Declaration [Total Pages ]
  - a. ☐ Newly executed
  - b. ☐ Copy from prior application
  - i. ☐ Deletion of Inventor(s) Signed statement attached deleting inventor(s) named in the prior application
5. ☐ Incorporation by Reference: The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. ☐ Microfiche Computer Program
7. ☐ Nucleotide and/or Amino Acid Sequence Submission
  - a. ☐ Computer Readable Copy
  - b. ☐ Paper Copy
  - c. ☐ Statement verifying above copies

[Note Boxes 5 and 17 below]

## ACCOMPANYING APPLICATION PARTS

8. ☐ Assignment Papers
9. ☐ Power of Attorney
10. ☐ English Translation Document (if applicable)
11. ☐ Information Disclosure Statement (IDS)
  - ☐ PTO-1449 Form
  - ☐ Copies of IDS Citations
12. ☐ Preliminary Amendment
13. ☒ Return Receipt Postcard (Should be specifically itemized)
14. ☐ Small Entity Statement(s)
  - ☐ Enclosed
  - ☐ Statement filed in prior application; status still proper and desired
15. ☐ Certified Copy of Priority Document(s)
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17. If a **CONTINUING APPLICATION**, check appropriate box and supply the requisite information:  
☐ Continuation ☐ Divisional ☐ Continuation-in-part of prior application Serial No.

## APPLICATION FEES

APPLICATION FEES			
BASIC FEE			\$690.00
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total Claims	- 20 =		x \$18.00 \$
Independent Claims	- 3 =		x \$78.00 \$
<input type="checkbox"/> Multiple Dependent Claims(s) if applicable			+\$270.00 \$
Total of above calculations =			\$
Reduction by 50% for filing by small entity =			\$( )
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TOTAL =			\$690.00

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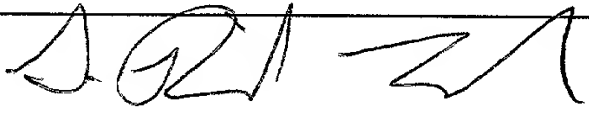
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19. ☒ A check in the amount of \$ 690.00 is enclosed.
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- a. ☒ Fees required under 37 CFR 1.16.
  - b. ☒ Fees required under 37 CFR 1.17.
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21. ☐ The Commissioner is hereby generally authorized under 37 CFR 1.136(a)(3) to treat any future reply in this or any related application filed pursuant to 37 CFR 1.53 requiring an extension of time as incorporating a request therefor, and the Commissioner is hereby specifically authorized to charge Deposit Account No. 13-2490 for any fee that may be due in connection with such a request for an extension of time.

**22. CORRESPONDENCE ADDRESS**

Name	<b>McDonnell Boehnen Hulbert &amp; Berghoff</b>
Address	32 <sup>nd</sup> Floor, 300 South Wacker Drive
City, State, Zip	Chicago, Illinois 60606

**23. SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED**

Name	S. Richard Carden Reg. No. 44,588
Signature	
Date	June 19, 2000

UTILITY (Rev. 11/18/97)

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CERTIFICATE OF MAILING

PATENT

Express Mail No. EL007258514US

Deposited: June 19, 2000

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By: Julie A. Goureaux

In re the Application of: Mark O. Vogel.

Docket No. MBHB00-009

For: METHOD FOR USING AN INITIAL MAINTENANCE OPPORTUNITY  
FOR NON-CONTENTION RANGING

- X Transmittal Letter  
X Specification (26 sheets)  
X Drawings (5 sheets)  
X Filing Fee (Large Entity)  
X Return Post Card

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1990-1991		1991-1992		1992-1993		1993-1994		1994-1995		1995-1996		1996-1997		1997-1998		1998-1999		1999-2000		2000-2001		2001-2002		2002-2003		2003-2004		2004-2005		2005-2006		2006-2007		2007-2008		2008-2009		2009-2010		2010-2011		2011-2012		2012-2013		2013-2014		2014-2015		2015-2016		2016-2017		2017-2018		2018-2019		2019-2020		2020-2021		2021-2022		2022-2023		2023-2024		2024-2025		2025-2026		2026-2027		2027-2028		2028-2029		2029-2030		2030-2031		2031-2032		2032-2033		2033-2034		2034-2035		2035-2036		2036-2037		2037-2038		2038-2039		2039-2040		2040-2041		2041-2042		2042-2043		2043-2044		2044-2045		2045-2046		2046-2047		2047-2048		2048-2049		2049-2050		2050-2051		2051-2052		2052-2053		2053-2054		2054-2055		2055-2056		2056-2057		2057-2058		2058-2059		2059-2060		2060-2061		2061-2062		2062-2063		2063-2064		2064-2065		2065-2066		2066-2067		2067-2068		2068-2069		2069-2070		2070-2071		2071-2072		2072-2073		2073-2074		2074-2075		2075-2076		2076-2077		2077-2078		2078-2079		2079-2080		2080-2081		2081-2082		2082-2083		2083-2084		2084-2085		2085-2086		2086-2087		2087-2088		2088-2089		2089-2090		2090-2091		2091-2092		2092-2093		2093-2094		2094-2095		2095-2096		2096-2097		2097-2098		2098-2099		2099-2100		2100-2101		2101-2102		2102-2103		2103-2104		2104-2105		2105-2106		2106-2107		2107-2108		2108-2109		2109-2110		2110-2111		2111-2112		2112-2113		2113-2114		2114-2115		2115-2116		2116-2117		2117-2118		2118-2119		2119-2120		2120-2121		2121-2122		2122-2123		2123-2124		2124-2125		2125-2126		2126-2127		2127-2128		2128-2129		2129-2130		2130-2131		2131-2132		2132-2133		2133-2134		2134-2135		2135-2136		2136-2137		2137-2138		2138-2139		2139-2140		2140-2141		2141-2142		2142-2143		2143-2144		2144-2145		2145-2146		2146-2147		2147-2148		2148-2149		2149-2150		2150-2151		2151-2152		2152-2153		2153-2154		2154-2155		2155-2156		2156-2157		2157-2158		2158-2159		2159-2160		2160-2161		2161-2162		2162-2163		2163-2164		2164-2165		2165-2166		2166-2167		2167-2168		2168-2169		2169-2170		2170-2171		2171-2172		2172-2173		2173-2174		2174-2175		2175-2176		2176-2177		2177-2178		2178-2179		2179-2180		2180-2181		2181-2182		2182-2183		2183-2184		2184-2185		2185-2186		2186-2187		2187-2188		2188-2189		2189-2190		2190-2191		2191-2192		2192-2193		2193-2194		2194-2195		2195-2196		2196-2197		2197-2198		2198-2199		2199-2200		2200-2201		2201-2202		2202-2203		2203-2204		2204-2205		2205-2206		2206-2207		2207-2208		2208-2209		2209-2210		2210-2211		2211-2212		2212-2213		2213-2214		2214-2215		2215-2216		2216-2217	
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**A corporation of the State of Delaware**

# METHOD FOR USING AN INITIAL MAINTENANCE OPPORTUNITY FOR NON-CONTENTION RANGING

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present invention relates to communications in computer networks. In particular, the invention relates to ranging methods in a data-over-cable system.

### 2. Description of the Related Art

Cable television networks such as those provided by Comcast Cable Communications, Inc., of Philadelphia, Pennsylvania, Cox Communications of Atlanta, Georgia, Tele-Communications, Inc., of Englewood Colorado, Time-Warner Cable, of Marietta Georgia, Continental Cablevision, Inc., of Boston Massachusetts, and others provide cable television services to a large number of subscribers over a large geographical area. The cable television networks typically are interconnected by cables such as coaxial cables or a Hybrid Fiber/Coaxial ("HFC") cable system which have data rates of about 10 Mega-bits-per-second ("Mbps") to about 30+ Mbps.

The Internet, a world-wide network of interconnected computers, provides multi-media content including audio, video, graphics and text that typically requires a large bandwidth for downloading and viewing. Most Internet Service Providers ("ISPs") allow customers to connect to the Internet via a serial telephone line from a Public Switched Telephone Network ("PSTN") at data rates including 14,400 bps, 28,800 bps, 33,600 bps, 56,000 bps and others that are much slower than the about 10 Mbps to about 30+ Mbps available on a coaxial cable or HFC cable system on a cable television network.

With the explosive growth of the Internet, many customers have desired to use the larger bandwidth of a cable television network to connect to the Internet and other computer networks. Cable modems, such as those provided by 3Com Corporation, of Santa Clara, California, Motorola Corporation, of Arlington Heights, Illinois, Hewlett-Packard Co., of Palo Alto, California, Bay Networks, of Santa Clara, California, Scientific-Atlanta, of Norcross, Georgia, General Instruments, of Horsham, Pennsylvania, and others offer customers higher-speed connectivity to the Internet, an intranet, Local Area Networks ("LANs") and other computer networks via cable television networks. These cable modems currently support a data connection to the Internet and other computer networks via a cable television network with a data rate of up to about 30+ Mbps, which is a much larger data rate than can be supported by a modem used over a serial telephone line.

Many cable television networks, however, provide only uni-directional cable systems, supporting only a "downstream" cable data path. A downstream data path is the flow of data to a customer from a cable system "headend" - a central location in the cable television network that is responsible for sending cable signals in the downstream direction. Traditionally, cable television networks provided one-way cable systems with a return "upstream" data path via a telephone network (i.e., a "telephony return"), such as a public switched telephone network provided by AT&T, GTE, Sprint, MCI and others. An upstream data path is the flow of data from the customer back to the cable system headend. A cable television system with an upstream connection to a telephony network is called a "data-over-cable system with telephony return."

As the cable television network has developed, two-way cable systems without telephony returns, wherein both downstream and upstream flow occur on the cable network, have become

increasingly prevalent. In a two-way cable system, customer premise equipment sends response data packets to the cable modem, which sends the data packets upstream via the cable television network to the cable modem termination system. The cable modem termination system sends the data packets to appropriate hosts on the data network and sends the response data packets back to the appropriate cable modem.

As a cable modem is initialized in a data-over-cable system, it registers with a cable modem termination system to allow the cable modem to receive data over a cable television connection from a data network (e.g., the Internet, a WAN or a LAN). The cable modem forwards configuration information it receives in a configuration file during initialization to the cable modem termination system as part of a registration request message. A cable modem also helps initialize and register any attached customer premise equipment with the cable modem termination system.

When a cable modem initializes on a cable television network, it uses a ranging process to determine the appropriate transmission parameters for its data transfer. For a description of the ranging process, see DOCSIS Radio Frequency Interface Specification SP-RFIv1.1-I03-991105 (hereinafter "DOCSIS RFI Spec 1.1"), which is incorporated herein by reference. Under existing ranging procedures, the cable modem sends a ranging message at an initial maintenance opportunity. The initial maintenance opportunity is a contention opportunity under existing standards, and thus any cable modem attached to the network may be attempting to use the same opportunity. If two or more cable modems attempt to use the same initial maintenance opportunity, a collision occurs and the cable modem termination system does not receive any of the ranging messages. When the cable modems fail to receive a response from the cable modem

termination system, the modems determine a random “backoff period” that the modem will wait before attempting to resend the ranging request.

As the number of cable modems using cable networks increases, this method will become increasingly inefficient. In order to accommodate a larger number of modems on the network, the modems may need to use larger backoff periods. Moreover, there is no guarantee that another collision will not occur when the modem again transmits its ranging request. These limitations will lead to an increased number of ranging attempts that a cable modem must perform before accessing the cable modem termination system. The effects of these limitations will be especially pronounced when a downstream channel fails, and all the cable modems previously using that channel must re-initialize on another channel or on the same channel after it comes back online.

There is therefore a need in the art for an improved method of ranging.



## SUMMARY OF THE INVENTION

In a first aspect, the invention provides a controlled, deterministic method of preventing collisions when a cable modem registers with a cable modem termination system on a cable television network following failure of a primary communications channel between the cable modem and the cable modem termination system. The method provides a service identifier that is transmitted to the cable modem during initial registration of the cable modem with the cable modem termination system. Upon registration of the cable modem with the cable modem termination system, the cable modem stores the service identifier in memory. After failure of the primary channel, the cable modem reinitializes on the cable network and waits for transmission of a bandwidth allocation map from the cable modem termination system. When the cable modem receives the bandwidth allocation map, it determines if the map contains an initial maintenance opportunity having a unicast, broadcast or multicast associated identifier, or a combination thereof. If the map contains an initial maintenance opportunity having a unicast associated identifier, the cable modem compares the service identifier stored in its memory with the unicast associated identifier for the initial maintenance opportunity information element of the bandwidth allocation map. If the service identifiers match, the cable modem uses the initial maintenance opportunity having a unicast associated identifier contained in the information element of the bandwidth allocation map to range on the network. If the cable modem determines that the bandwidth allocation map does not contain a initial maintenance opportunity having a unicast associated identifier, the cable modem uses standard contention ranging with an initial maintenance opportunity having a broadcast or multicast associated identifier in the bandwidth allocation map to range on the network. If the cable modem determines that the bandwidth allocation map does contain a initial maintenance opportunity having a unicast

associated identifier, but the service identifiers do not match, the cable modem uses standard contention ranging with an initial maintenance opportunity having a broadcast or multicast associated identifier in the bandwidth allocation map.

In accordance with a preferred embodiment of the present invention, the bandwidth allocation map contains a plurality of initial maintenance opportunities having associated identifiers, wherein the associated identifiers are broadcast, multicast or unicast. In a further preferred embodiment, the cable modem reads only the first of the plurality of initial maintenance opportunities in the bandwidth allocation map. If the associated identifier for the initial maintenance opportunity is unicast and corresponds to the service identifier in the cable modem, the cable modem ranges on the network using non-contention ranging, otherwise the cable modem uses standard contention ranging.

In a further preferred embodiment, the cable modem reads all of the initial maintenance opportunities in the bandwidth allocation map prior to ranging on the cable television network. If any of the initial maintenance opportunities has a unicast associated identifier corresponding to the service identifier stored in the cable modem, the cable modem uses that initial maintenance opportunity having a unicast associated identifier to range on the cable television network. Otherwise, the cable modem uses an initial maintenance opportunity having a broadcast or multicast associated identifier in the bandwidth allocation map to range on the cable television network.

The foregoing and other aspects and advantages of illustrative embodiments of the present invention will be more readily apparent from the following detailed description, which proceeds with references to the accompanying drawings.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

Preferred embodiments of the present invention are described with reference to the following drawings, wherein:

FIG. 1 is a block diagram illustrating a two-way cable modem system;

FIG. 2 is a block diagram illustrating a protocol stack for a cable modem;

FIG. 3 is a block diagram illustrating an Upstream Channel Descriptor message structure;

FIG. 4 is a block diagram illustrating a bandwidth allocation map;

FIG. 5 is a block diagram illustrating a bandwidth allocation map information element;

and

FIG. 6 is a flow diagram illustrating a preferred embodiment of a non-contention ranging process.

## **DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS**

### **Exemplary data-over-cable system**

FIG. 1 is a block diagram illustrating an exemplary data-over-cable system **10** with both telephony return **22** and bi-directional data flow over the cable network **14**. The preferred embodiments, however, utilize the bi-directional data path (i.e., both downstream and upstream communication via the cable network **14**), rather than the telephony return **22**. In a data-over cable system **10** without telephony return, customer premise equipment (“CPE”) **18** or a cable modem (“CM”) **16** has an upstream connection to the cable modem termination system (“CMTS”) **12** via a cable television connection, a wireless connection, a satellite connection, or a connection via other technologies to send data upstream to the cable modem termination system. The data-over-cable system **10** shows the CMTS **12** connected to the CM**16** via a cable television network **14**, hereinafter the cable network **14**. FIG. 1 illustrates one CMTS **12**. However, data-over-cable system **10** may include multiple CMTSs **12**.

In one preferred embodiment of the present invention, the CMTS **12** is a Total Control hub by 3Com Corporation of Santa Clara, California, with a cable modem termination unit. A Total Control hub is a chassis with multiple networking cards connected by a common bus. An exemplary Total Control hub is described in U.S. Patent No. 5,528,595, granted to Dale M. Walsh et al., and is incorporated herein by reference. However, CMTS **12** could also be another network server including those by Lucent Technologies of Murray Hill, New Jersey, Livingston Enterprises, Inc. of Pleasanton, California, Ascend Communications of Alameda, California, Cisco Systems, Inc., of San Jose, California and others.

The cable network **14** includes cable television networks such as those provided by Comcast Cable Communications, Inc., of Philadelphia, Pennsylvania, Cox Communications, or

Atlanta, Georgia, Tele-Communications, Inc., of Englewood Colorado, Time-Warner Cable, of Marietta, Georgia, Continental Cablevision, Inc., of Boston, Massachusetts, and others. As noted above, the cable network **14** is connected to the Cable Modem (“CM”) **16** over a bi-directional cable connection. CM **16** may be any commercially available cable modem such as those  
5 provided by 3Com Corporation of Santa Clara, California, Motorola Corporation of Arlington Heights, Illinois, Hewlett-Packard Co. of Palo Alto, California, Bay Networks of Santa Clara, California, Scientific-Atlanta, of Norcross, Georgia, General Instruments of Horsham, Pennsylvania, and others. FIG. 1 illustrates one CM **16**; however, in a typical data-over-cable system, hundreds or thousands of CMs **16** are connected to the CMTS **12**. The CM **16** is  
10 connected to the CPE **18**, such as a personal computer system, via a Cable Modem-to-CPE Interface (“CMCI”) **20**. One CPE **18** is illustrated in FIG. 1; however, the CM **16** may be connected to multiple CPEs **18** attached.

The CMTS **12** is located at a “headend” **26** of the cable system **10**. Content servers, operations servers, administrative servers and maintenance servers used in data-over-cable  
15 system **10** (not shown in FIG. 1) may be at the headend **26** or in different locations. Access points to the data-over-cable system **10** are connected to one or more CMTS **12**, or cable headend access points. Such configurations may be “one-to-one”, “one-to-many,” or “many-to-many,” and may be interconnected to other Local Area Networks (“LANs”) or Wide Area Networks (“WANs”).

20 The CMTS **12** is connected to a data network **28** by a CMTS-Network System Interface (“CMTS-NSI”) **32**. The preferred embodiments are, however, not limited to the architecture of the data-over-cable system **10** illustrated in FIG. 1, and more or fewer components, connections and interfaces could alternatively be used.

## Network device protocol stack

FIG. 2 is a block diagram illustrating a protocol stack 36 for network devices in the data-over-cable system 10. In one preferred embodiment of the present invention, network devices in the data-over-cable system 10 are compliant with Data-Over-Cable-Service-Interface-Specification (“DOCSIS”) standards from the Multimedia Cable Network Systems (“MCNS”), which are incorporated herein by reference. The DOCSIS standards can be found on the World Wide Web at the Universal Resource Locator (“URL”) “www.cablemodem.com.”

FIG. 2 illustrates the downstream and upstream protocols used, for example, in the CM 16. As is known in the art, the Open System Interconnection (“OSI”) model is used to describe open computer networks. The OSI model consists of seven layers including from lowest-to-highest, a physical, data-link, network, transport, session, presentation and application layer. The physical layer transmits bits over a communication link. The data link layer transmits error free frames of data. The network layer transmits and routes data packets.

For downstream data transmission, network devices, including for example the CM 16, are connected to the cable network 14 in a physical layer 38 via a Radio Frequency (“RF”) Interface 40. The RF interface 40 and the MAC layer 44 are used for an upstream cable connection in a data-over-cable system 10 without telephony return. In a preferred embodiment of the present invention, the RF Interface 40 has an operation frequency range of 50 megahertz (“MHz”) to 1 gigahertz (“GHz”) and a channel bandwidth of 6 MHz. However, other frequency ranges may alternatively be used

The RF interface 40 uses a signal modulation method, such as Quadrature Amplitude Modulation (“QAM”). As is known in the art, QAM is used as a means of encoding digital

information over radio, wire, or fiber optic transmission links. QAM is a combination of amplitude and phase modulation and is an extension of multiphase phase-shift-keying. QAM can have any number of discrete digital levels typically including 4, 16, 64 or 256 levels. In one embodiment of the present invention, QAM-64 is used in the RF interface 40. However, other operating frequencies and modulation methods may alternatively be used, including for example, Quadrature Phase Shift Keying (“QPSK”) modulation). The RF interface 40 is preferably compliant with the Institute of Electrical and Electronic Engineers (“IEEE”) standard 802.14 for cable modems, the contents of which are incorporated herein by reference. IEEE standards can be found on the World Wide Web at the URL “www.ieee.org.” Other RF interfaces 40 may alternatively be used, including, for example, RF interfaces from MCNS.

Above the RF interface 40 in the protocol stack 36 a transmission convergence sublayer 41, which is only present in the downstream direction. Transmission convergence sublayer 41 provides for the transmission of services such as digital video over the physical layer 38 bitstream. For more information on transmission convergence sublayer 41, reference may be made to DOCSIS Radio Frequency Interface Specification SP-RFIV1.1-I03-991105 (hereinafter “DOCSIS RFI Spec 1.1”), the contents of which are incorporated herein by reference.

Above the RF interface 40 in the upstream direction, and transmission convergence sublayer 41 in the downstream direction, is a data-link layer 42. Data-link layer comprises a Medium Access Control (“MAC”) layer 44, a link security layer 46, and a logical link control (“LLC”) layer 48. As is known in the art, the MAC layer 44 controls access to a transmission medium via physical layer 38. For more information on the MAC layer protocol 44, reference may be made to IEEE 802.14 for cable modems. However, other MAC layer protocols 44 may alternatively be used, including, for example, MCNS MAC layer protocols. Above the MAC

layer 44 is an optional link security protocol stack 46. Link security protocol stack 46 prevents unauthorized users from making a data connection from the cable network 14. Above the link security protocol stack 46 is LLC layer 48. For more information on LLC layer 48, reference may be made to ISO/IEC 10039, which is incorporated herein by reference.

5 Above both the downstream and upstream data-link layers 42, in a network layer 52, is an Internet Protocol ("IP") layer 54. IP layer 54, hereinafter IP 54, roughly corresponds to OSI layer 3, the network layer, but is typically not defined as part of the OSI model. As is known in the art, IP 54 is a routing protocol designed to route traffic within a network or between networks. For more information on IP 54, reference may be made to RFC-791, J. Postel,  
10 *Internet Protocol*, Sep. 1, 1981, the contents of which are incorporated herein by reference.

Internet Control Message Protocol ("ICMP") layer 56 is used for network management. The main functions of ICMP layer 56, hereinafter ICMP 56, include error reporting, reachability testing (e.g., "pinging"), congestion control, route-change notification, performance, subnet addressing and others. Because IP 54 is an unacknowledged protocol, datagrams may be  
15 discarded and ICMP 56 is used for error reporting. For more information on ICMP 56, reference may be made to RFC-792, J. Postel, *Internet Control Message Protocol*, Sep. 1, 1981, the contents of which are incorporated herein by reference.

Above IP 54 and ICMP 56 is a transport layer 58 with a User Datagram Protocol ("UDP") layer 60. UDP layer 60, hereinafter UDP 60, roughly corresponds to OSI layer 4, the  
20 transport layer, but is typically not defined as part of the OSI model. As is known in the art, UDP 60 provides a connectionless mode of communications with datagrams. For more information on UDP 60 reference may be made to RFC-768, J. Postel, *User Datagram Protocol*, Aug. 28, 1990, the contents of which are incorporated herein by reference. Transmission Control



Protocol ("TCP") may also be used in the transport layer 58. For more information on TCP, reference may be made to RFC-793, J. Postel, *Transmission Control Protocol*, Sep. 1, 1981, the contents of which are incorporated by reference.

Above the network layer are a Simple Network Management Protocol ("SNMP") layer 62, Trivial File Transfer Protocol ("TFTP") layer 64, and Dynamic Host Configuration Protocol ("DHCP") layer 66. SNMP layer 62 is used to support network management functions. For more information on SNMP layer 62, reference may be made to the contents of which are RFC-1157, J.D. Case et al., *Simple Network Management Protocol*, May 1, 1990, incorporated herein by reference. TFTP layer 64 is a file transfer protocol used to download files and configuration information. For more information on TFTP layer 64, reference may be made to RFC-1350, K. Sollins, *The TFTP Protocol (Revision 2)*, July 1992, the contents of which are incorporated herein by reference. DHCP layer 66 is a protocol for passing configuration information to hosts on an IP 54 network. For more information on DHCP layer 66, see RFC-2131, R. Droms, *Dynamic Host Control Protocol*, Mar. 1997, and RFC-2132, S. Alexander and R. Droms, *DHCP Options and BOOTP Vendor Extensions*, Mar. 1997, the contents of each of which are incorporated herein by reference.

The CM 16 supports transmission and reception of IP 54 datagrams as specified for example by RFC-791. The CMTS 12 may also perform filtering of IP 54 datagrams. The CM 16 is also preferably configurable for IP 54 datagram filtering to restrict the CM 16 and the CPE 18 to the use of only their assigned IP 54 addresses. The CM 16 is preferably configurable for IP 54 datagram UDP 60 port filtering (i.e., deep filtering).

The CM 16 forwards IP 54 datagrams destined to an IP 54 unicast address across the cable network 14. Some routers have security features intended to filter out invalid users who

alter or masquerade packets as if sent from a valid user. Since routing policy is under the control of network operators, such filtering is a vendor specific implementation. The CM 16 also forwards IP 54 datagrams destined to an IP 54 multicast address across the cable network 14. The CM 16 is preferably configurable to keep IP 54 multicast routing tables and to use group membership protocols.

An operating environment for the CMTS 12, the CM 16, the CPE 18, and other network devices includes a processing system with at least one high speed Central Processing Unit ("CPU") and a memory system. In accordance with the practices of persons skilled in the art of computer programming, the present invention is described below with reference to acts and symbolic representations of operations or instructions that are performed by the processing system, unless indicated otherwise. Such acts and operations or instructions are sometimes referred to as being "computer-executed," or "CPU executed."

It will be appreciated that the acts and symbolically represented operations or instructions include the manipulation of electrical signals by the CPU. The memory locations where data are maintained are physical locations that have particular electrical, magnetic, optical, or organic properties corresponding to the data bits. The data may also be maintained on a computer readable medium including magnetic disks, optical disks, organic disks, and any other volatile or non-volatile mass storage system readable by the CPU. The computer readable medium may include cooperating or interconnected computer readable media, which exist exclusively on the processing system or distributed among multiple interconnected processing systems that may be local or remote to the processing system.

#### **Initialization of a cable modem**

When the CM 16 is initially powered on, the CM 16 scans for a valid available downstream channel. Once the CM 16 has acquired a valid downstream channel, the CM 16 waits for an Upstream Channel Descriptor (“UCD”) from the CMTS 12. The UCD is used to provide transmission parameters for all available upstream channels. Information in the UCD is used by the CM 16 to determine whether the CM 16 can use the given upstream channel. The UCD is transmitted by the CMTS 12 as a MAC management message at a periodic opportunity (e.g., every 2 seconds). To provide for flexibility, the UCD message parameters are encoded in a Type/Length/Value (“TLV”) form.

FIG. 3 is a block diagram illustrating a UCD message structure 70. The message structure 70 includes a MAC 44 management header 72 and channel descriptor (“CD”) parameters 74. The CD parameters 74 provide the necessary information for the CM 16 to communicate upstream with the CMTS 12. The CD parameters 74 preferably include the parameters shown in Table 1 and may contain optional vendor specific parameters. However, more or fewer parameters than are illustrated in Table 1 may alternatively be used.

CD Parameters 74	Description
<b>Upstream Channel ID</b>	This parameter is selected by CMTS 12 to identify the upstream channel referred to by the UCD.
<b>Configuration Change Count</b>	This parameter contains a value that is incremented by one each time the information in the UCD changes.
<b>Mini-Slot Size</b>	This parameter defines the size of the mini-slot for the upstream channel. The mini-slot is the granularity level for upstream operations.
<b>Downstream Channel ID</b>	This parameter contains the ID of the downstream channel on which the UCD is transmitted.
<b>Overall Channel Information</b>	This parameter contains TLV encoded data including symbol rate, upstream center frequency, and a preamble superstring.

<b>Burst Descriptors</b>	This parameter contains compound TLV data that defines the physical layer characteristics to be used for each type of upstream usage opportunity.
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Table 1.

### Non-Contention Ranging

Once the CM 16 has acquired valid downstream and upstream channels, the CM 16 begins the ranging process. The CM 16 waits for transmission of a bandwidth allocation map (“MAP”) 100 associated with the upstream channel from the CMTS 12. The MAP 100 is in the form of a MAC management message and contains information used by the CM 16 to determine the timing of its transmissions back to the CMTS 12. FIG. 4 illustrates a MAP 100. The MAP 100 includes a MAC management message header 102, an upstream channel ID field 104, a UCD count field 106, a number of elements field 108, a reserved field 110 for alignment, an allocation start time (“Alloc start time”) field 112, an acknowledge (“Ack”) time field 114, a ranging backoff start field 116, a ranging backoff end field 118, a data backoff start field 120, a data backoff end field 122, and one or more MAP information elements (“IE”) 124.

As illustrated in FIG. 4, the upstream channel ID field 104 is one byte and identifies the upstream channel referred to by MAP 100. The UCD Count 106 is one byte and is identical to the configuration change count described above with reference to the CD parameters 74. The number of elements field 108 is one byte and indicates the number of MAP IEs 124 in MAP 100. The alloc start time field 112 is four bytes and provides the start time, in mini-slots, for IE 124 assignments in MAP 100 with reference to the time of CMTS 12 initialization. The ack time field 114 is four bytes and is used by the CM 16 to detect collisions. The ack time 114 identifies the latest time in mini-slots of the upstream transmissions with reference to CMTS 12 initialization. Ranging backoff start field 116 is one byte and has a value of 0-15. This field

provides the initial back-off window for contention ranging. Ranging backoff end field **118** is one byte and has a value of 0-15. This field provides the final back-off window for contention ranging. Data backoff start field **120** is one byte, has a value of 0-15, and provides the initial back-off window for contention data and requests. Data backoff end field **122** is one byte, has a value of 0-15, and provides the final back-off window for contention data and requests.

MAP IEs **124** are each four bytes. A series of MAP IEs **124** is illustrated in FIG. 5. Each MAP IE **124** comprises a 14-bit service identifier (“SID”) **126**, a 4 bit opportunity usage code (“IUC”) **128**, and a 14-bit mini-slot offset **130**. A mini-slot offset is the time opportunity at which a given request may be transmitted by the CM **16** to the CMTS **12**. As an example, in contention ranging, an IE for an initial maintenance request has an IUC **128** of 3, a broadcast or multicast SID **126**, and a mini-slot offset **130** that indicates the start time of the mini-slot for transmitting initial ranging requests.

For non-contention ranging, the CMTS **12** uses unicast SIDs **126** in MAP IEs **124** for initial ranging. Under DOCSIS RFI Spec. 1.1, SIDs **126** for initial maintenance opportunities are broadcast or multicast. The preferred embodiments provide for the introduction of a initial maintenance opportunity having a unicast associated identifier SID **126**, wherein the unicast SID **126** is used by the CM **16** to range on the cable television network following failure of a primary channel between the CM **16** and the CMTS **12**.

In a preferred embodiment, the CMTS **12** maintains a pool of unicast SIDs **126** and a pool of broadcast or multicast SIDs **126**. Using the known pool of unicast SIDs **126**, the CMTS **12** sequentially schedules initial maintenance opportunities for the CMs **16**. This method requires that each CM **16** have a unique SID **126**, which the CM **16** obtains upon registration with the CMTS **12**, and therefore the method is used primarily for reinitializing a pool of

modems after a channel failure. Initial registration of the CM 16 with the CMTS 12 uses standard contention ranging procedures as described in DOCSIS RFI Spec 1.1. After initial registration with the CMTS 12, the CM 16 stores the unique SID 126 received from the CMTS 12 for use in non-contention ranging. In a preferred embodiment, the SID 126 is stored in a volatile memory component in the CM 16.

A preferred method for of non-contention ranging is illustrated in FIG. 6. Non-contention ranging, as such term is used herein, begins following a channel failure of sufficient duration that timeout periods for the CMs 16 have been exceeded. When the failed channel comes back on line, or when the CMs 16 attempt to use an alternate channel, the CMTS 12 determines, at step 200, which CMs 16 corresponding to the assigned unique SIDs 126 have been dropped from the network. At step 210, the CMTS 12 collects the SIDs 126 of the dropped CMs 16. CMTS 12 then, at step 220 transmits MAPs 100 containing initial maintenance opportunities containing the unique SIDs 126, as well as initial maintenance opportunities containing broadcast or multicast SIDs 126 usable by any CM 16 for standard contention ranging, thereby allowing new CMs 16, as well as CMs 16 with unique SIDs 126 that were not able to use their unicast opportunity, to register with the CMTS 12. After sending the MAPs 100, the CMTs proceeds in accordance with the standard ranging process at step 230.

Following the channel failure, the CM 16 determines, at step 240, that its timeout has been exceeded, and therefore that the channel has failed. The CM 16 proceeds to, stores the permanent SID 126 at step 250, reinitializes on the network and enters a waiting state at step 270. When the CM 16 receives MAP 100 at step 280, it proceeds to determine at step 290 whether the SID 126 in the MAP 100 is a unicast SID or a broadcast/multicast SID. In another embodiment, the CM 16 examines the IEs 124 in the MAP 100 sequentially and takes the first

initial maintenance opportunity available, whether the opportunity contains a broadcast, multicast or unicast associated SID 126. In a further preferred embodiment, CM 16 reads all IEs 124 in MAP 100 to determine if one of the IEs 124 is directed to the last known unicast SID 126 of the CM 16. If the appropriate unicast SID 126 appears in the MAP 100 at step 300, the CM 16 proceeds to step 310, where it bypasses the backoff parameters contained in MAP 100, at steps 320 and 330, and attempts to range on the cable television network using the unicast SID 126 and the last known transmission parameters associated with that unicast SID 126. If the CM 16 determines at step 290 that the appropriate unicast SID 126 is not in the MAP 100, the CM 16 proceeds to step 340 and uses a broadcast or multicast SID in the MAP 100 and standard contention ranging to range on the cable television network.

It should be understood that the programs, processes, methods and apparatus described herein are not related or limited to any particular type of computer or network apparatus (hardware or software), unless indicated otherwise. Various types of general purpose or specialized computer apparatus may be used with or perform operations in accordance with the teachings described herein.

In view of the wide variety of embodiments to which the principles of the present invention can be applied, it should be understood that the illustrated embodiments are exemplary only, and should not be taken as limiting the scope of the present invention. For example, the steps of the flow diagrams may be taken in sequences other than those described, and more or fewer elements may be used in the block diagrams. The claims should not be read as limited to the described order or elements unless stated to that effect. Therefore, all embodiments that come within the scope and spirit of the following claims and equivalents thereto are claimed as the invention.

## WHAT WE CLAIM IS:

1. A method of non-contention ranging for re-registering a cable modem with a cable modem termination system on a cable television network following the failure of a communications channel between the cable modem and the cable modem termination system,  
5 comprising the steps of:

(a) storing in the cable modem a first identifier for the cable modem;  
(b) determining that a timeout value for the cable modem has been exceeded;  
(c) reinitializing the cable modem on the cable television network;  
(d) transmitting from the cable modem termination system to the cable  
10 modem a data packet containing at least one initial maintenance opportunity;

(e) determining, at the cable modem, whether the at least one of initial maintenance opportunity comprises an initial maintenance opportunity having a unicast associated identifier;

(f) determining whether the initial maintenance opportunity having the  
15 unicast associated identifier is available for use by the cable modem; and

(g) when the initial maintenance opportunity having the unicast associated identifier is available for use by the cable modem, using the initial maintenance opportunity having the unicast associated identifier for non-contention ranging by the cable modem.

20 2. The method of Claim 1 wherein the step of determining whether the plurality of initial maintenance opportunities contains a initial maintenance opportunity having a unicast associated identifier comprises the steps of:



(a) reading by the cable modem the first of the plurality of initial maintenance opportunities; and

(b) determining by the cable modem if the first of the plurality of initial maintenance opportunities contains a unicast identifier,

5 wherein if the first of the plurality of second identifiers is not unicast, the cable modem uses the first of the plurality of initial maintenance opportunities for standard contention ranging.

3. The method of Claim 2 wherein the step of determining by the cable modem if the first of the plurality of initial maintenance opportunities is unicast comprises the steps of:

10 (a) reading by the cable modem an associated identifier for the initial maintenance opportunity; and

(b) determining by the cable modem if the associated identifier for the initial maintenance opportunity is unicast.

15 4. The method of Claim 3 wherein the step of determining by the cable modem whether the initial maintenance opportunity having a unicast associated identifier is available for use by the cable modem comprises the steps of:

(a) if the associated identifier for the initial maintenance opportunity is unicast, comparing the associated identifier for the initial maintenance opportunity with the first  
20 identifier stored in the cable modem; and

(b) if the associated identifier for the initial maintenance opportunity matches the first identifier stored in the cable modem, determining that the initial maintenance opportunity is available for use by the cable modem.

5. The method Claim 1 wherein the step of determining whether the plurality of initial maintenance opportunities contains a initial maintenance opportunity having a unicast associated identifier comprises the steps of:

5 (a) reading by the cable modem the first of the plurality of initial maintenance opportunities;

(b) determining by the cable modem if the first of the plurality of initial maintenance opportunities is unicast;

(c) if the initial maintenance opportunity is not unicast, repeating steps (a) and  
10 (b) for the next initial maintenance opportunity in the plurality of initial maintenance opportunities,

wherein if the plurality of initial maintenance opportunities does not contain a initial maintenance opportunity having a unicast associated identifier, the cable modem uses one of the plurality of initial maintenance opportunities for standard contention ranging.

15 6. The method of Claim 5 wherein the step of determining by the cable modem if the first of the plurality of initial maintenance opportunities is unicast comprises the steps of:

(a) reading by the cable modem an associated identifier for the initial maintenance opportunity; and

20 (b) determining by the cable modem if the associated identifier for the initial maintenance opportunity is unicast.

7. The method of Claim 6 wherein the step of determining by the cable modem whether the initial maintenance opportunity having a unicast associated identifier is available for use by the cable modem comprises the steps of:

(a) if the associated identifier for the initial maintenance opportunity is unicast, comparing the associated identifier for the initial maintenance opportunity with the first identifier stored in the cable modem; and

(b) if the associated identifier for the initial maintenance opportunity matches the first identifier stored in the cable modem, determining that the initial maintenance opportunity is available for use by the cable modem.

8. The method of Claim 1 wherein the data packet containing the plurality of initial maintenance opportunities is a bandwidth allocation map.

9. The method of Claim 8 wherein the plurality of initial maintenance opportunity comprises a plurality of bandwidth allocation map information elements.

10. The method of Claim 9 wherein the plurality of initial maintenance opportunities comprises a broadcast initial maintenance opportunity and a initial maintenance opportunity having a unicast associated identifier.

11. The method of Claim 9 wherein the plurality of initial maintenance opportunities comprises a multicast initial maintenance opportunity and a initial maintenance opportunity having a unicast associated identifier.

12. The method of Claim 1 wherein the first identifier is a service identifier.

13. The method of Claim 1 wherein the first identifier is transmitted from the cable  
5 modem termination system to the cable modem during registration of the cable modem with the  
cable modem termination system.

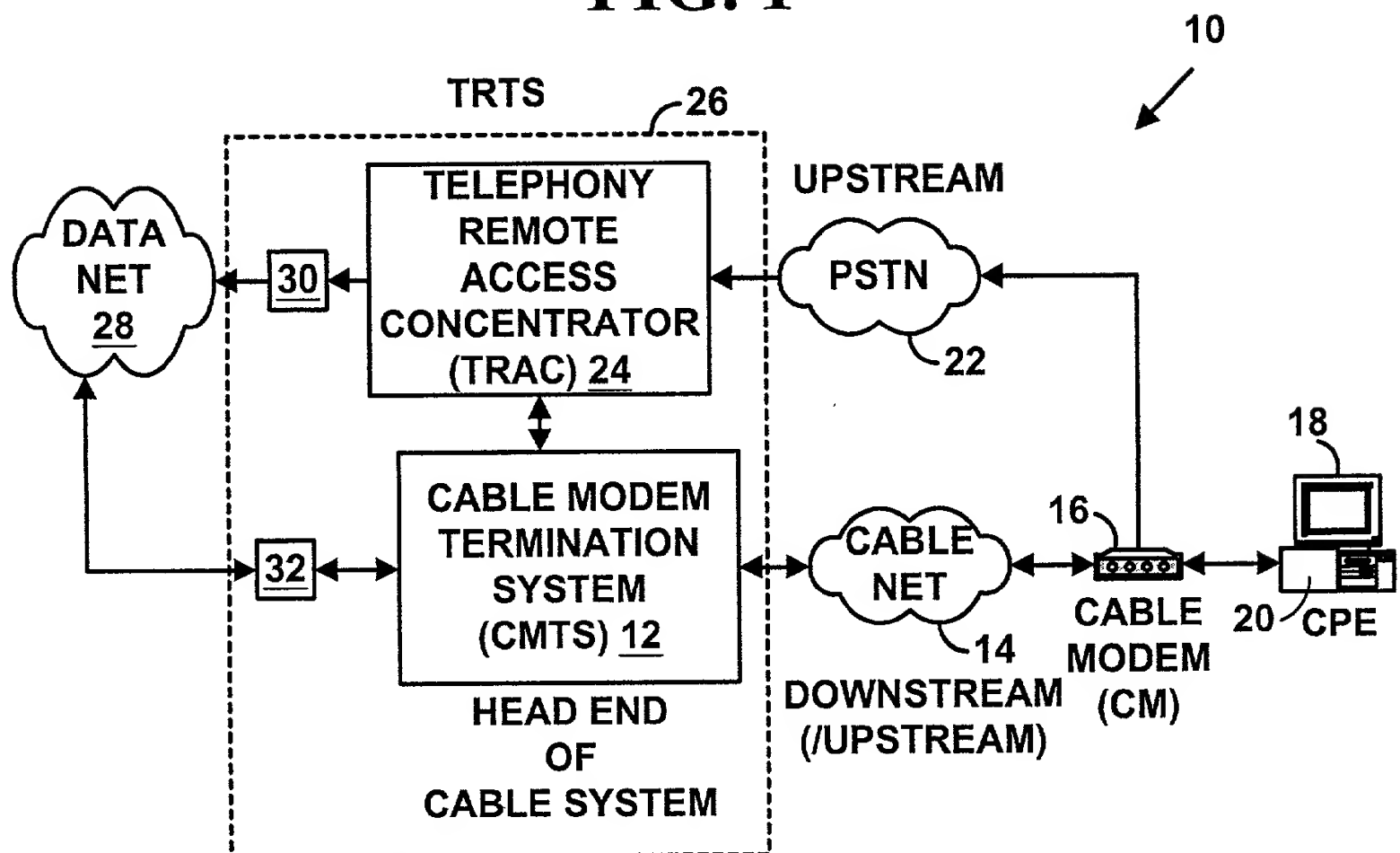
14. A computer readable medium having stored therein a set of routines for  
implementing the method of Claim 1.

10 15. The method of Claim 1 wherein the step of using the initial maintenance  
opportunity having a unicast associated identifier for non-contention ranging by the cable  
modem comprises transmitting a range request message from the cable modem to the cable  
modem termination system using a set of transmission parameters in use by the cable modem  
15 prior to failure of the communications channel.

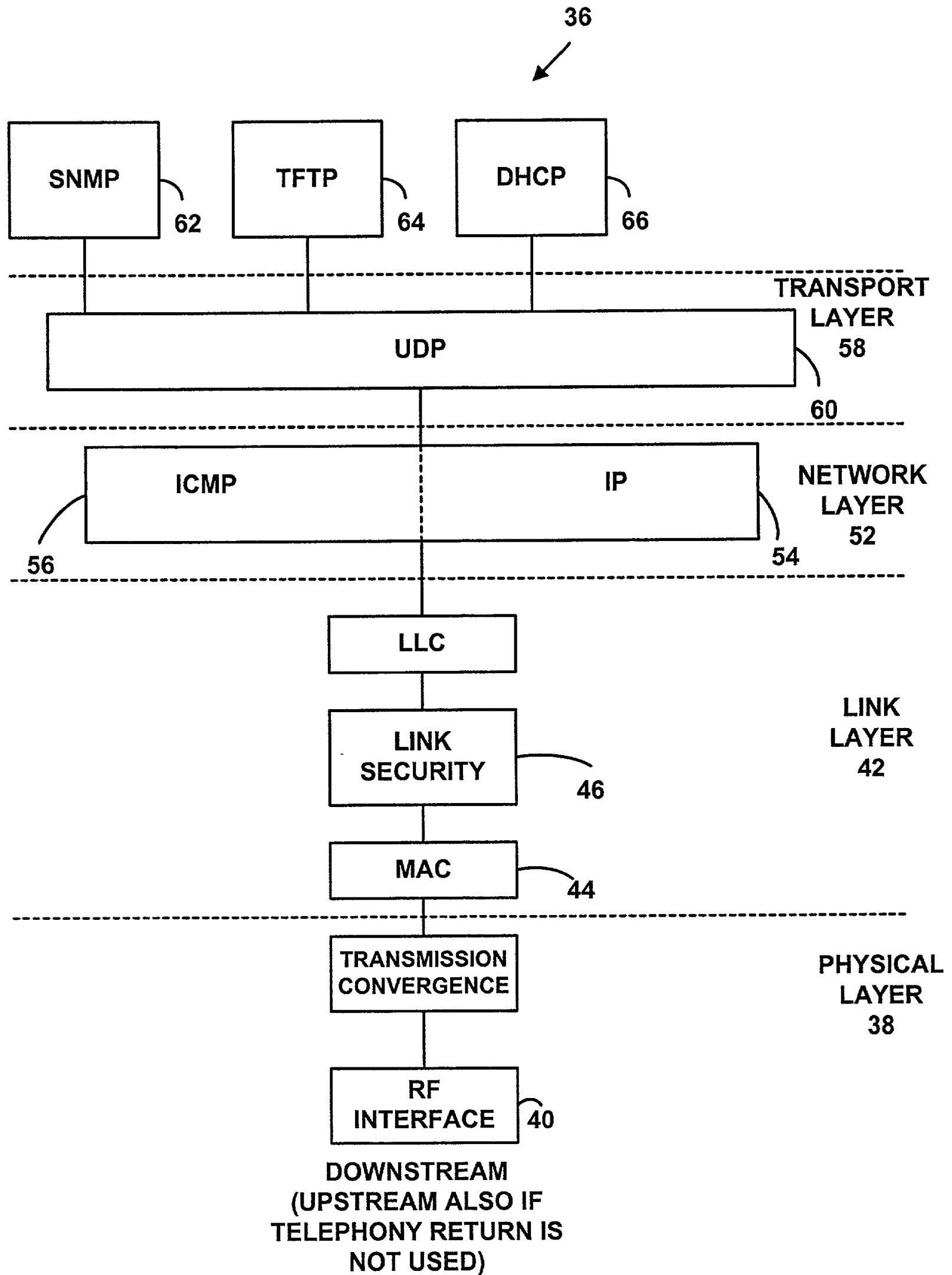
## ABSTRACT

A method of preventing collisions when a cable modem re-registers with a cable modem termination system on a cable television network following failure of a primary communications channel between the cable modem and the cable modem termination system. The method provides a service identifier that is transmitted to the cable modem during initial registration of the cable modem with the cable modem termination system. Upon registration of the cable modem with the cable modem termination system, the cable modem stores the service identifier in memory. After failure of the primary channel, the cable modem reinitializes on the cable network and waits for transmission of a bandwidth allocation map from the cable modem termination system. When the cable modem receives the bandwidth allocation map, it determines if the map contains a unicast initial maintenance opportunity. When the map contains a initial maintenance opportunity having a unicast associated identifier, the cable modem compares the service identifier stored in its memory with a unique service identifier contained in the initial maintenance opportunity information element of the bandwidth allocation map. When the service identifiers match, the cable modem then uses the initial maintenance opportunity having the unicast associated identifier contained in the information element of the bandwidth allocation map to re-register with the network.

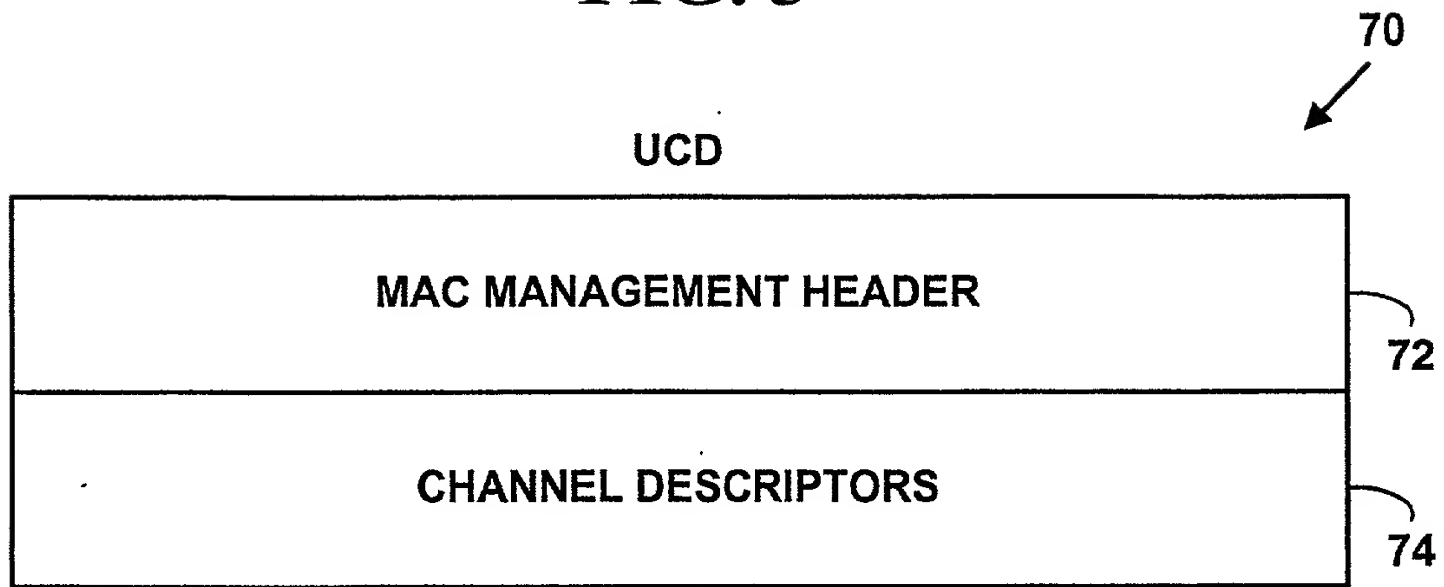
# FIG. 1



**FIG. 2**



**FIG. 3**





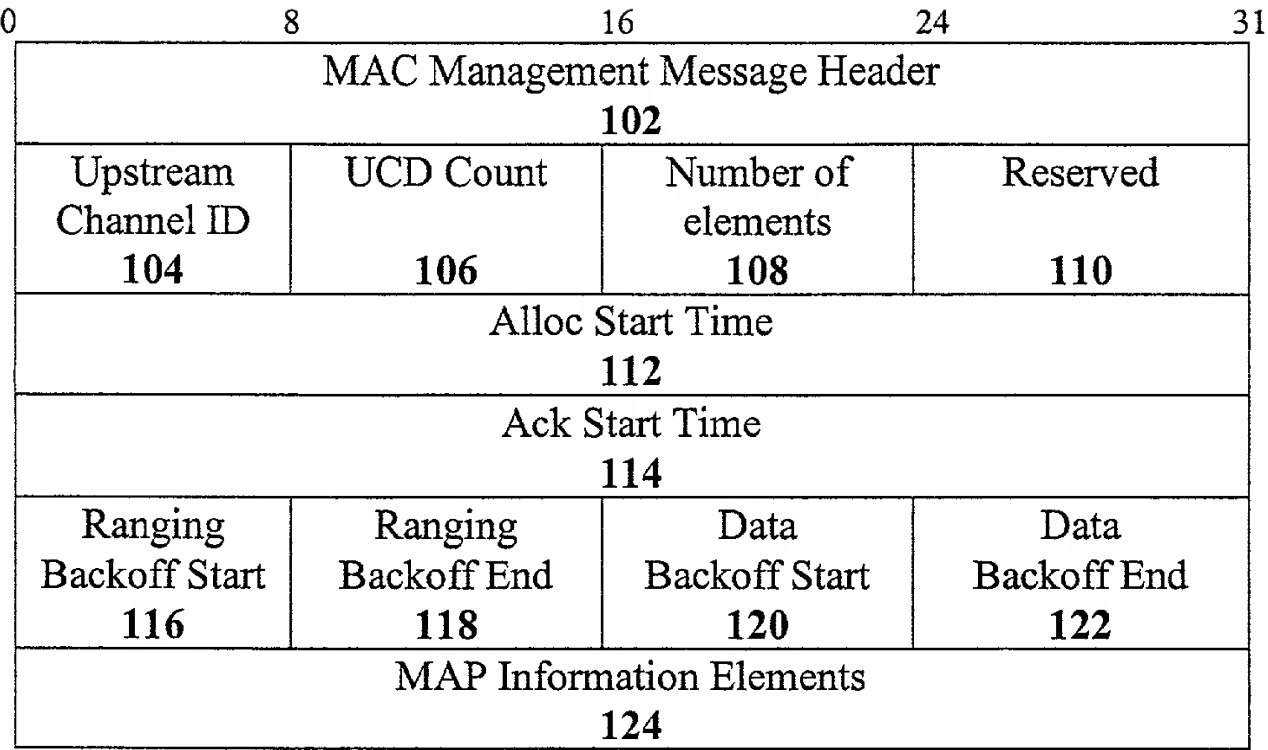


FIGURE 4

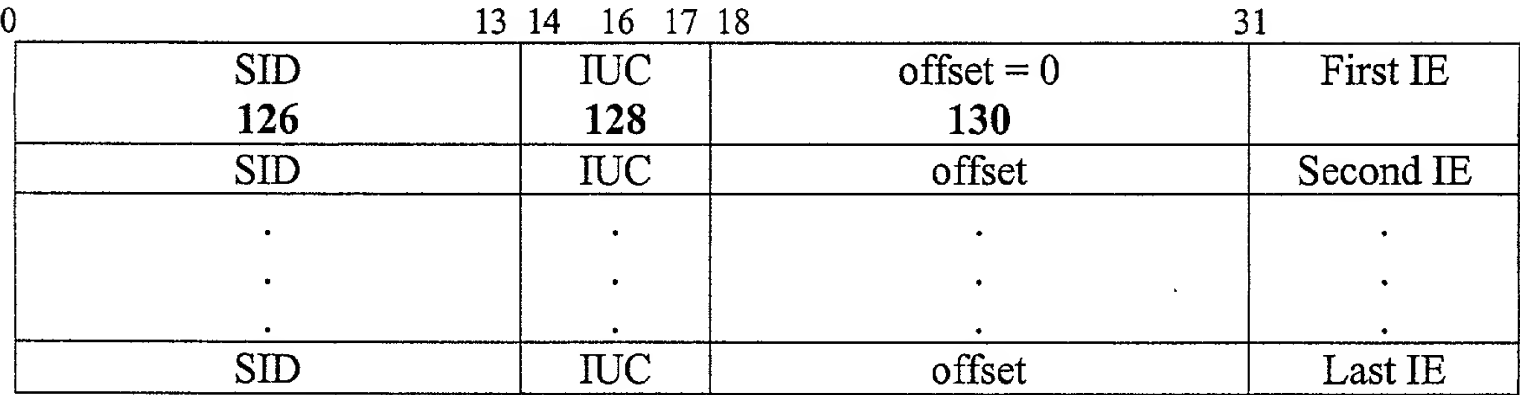
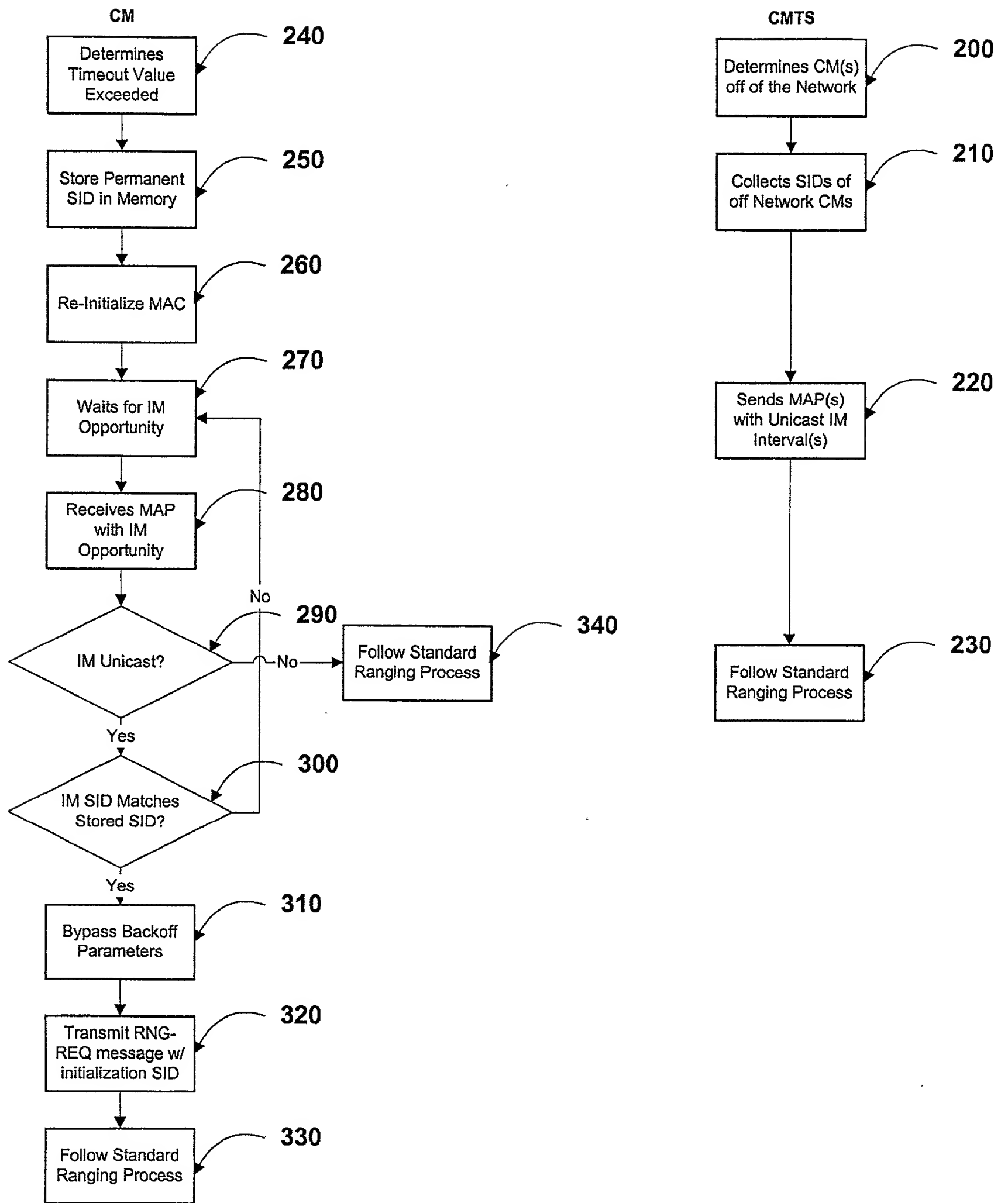
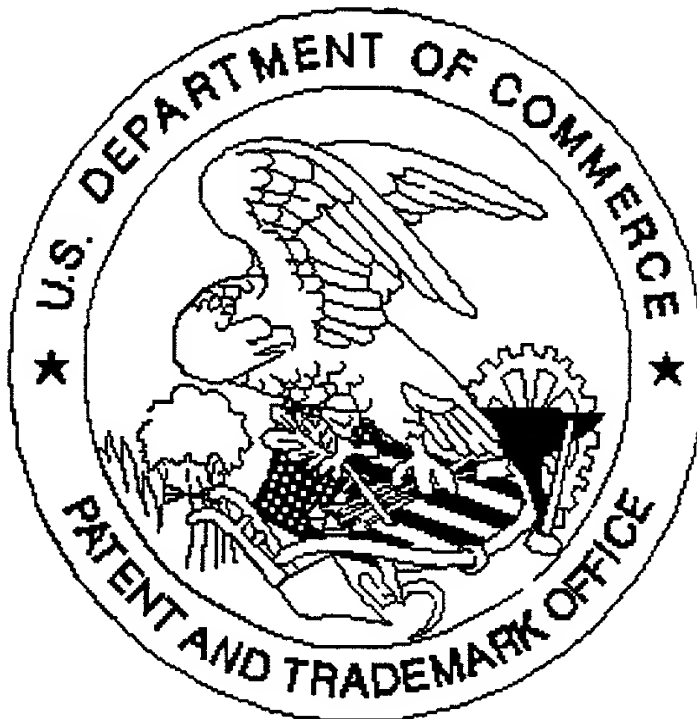


FIGURE 5

FIGURE 6



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